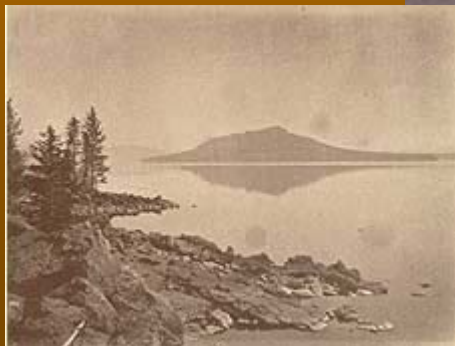


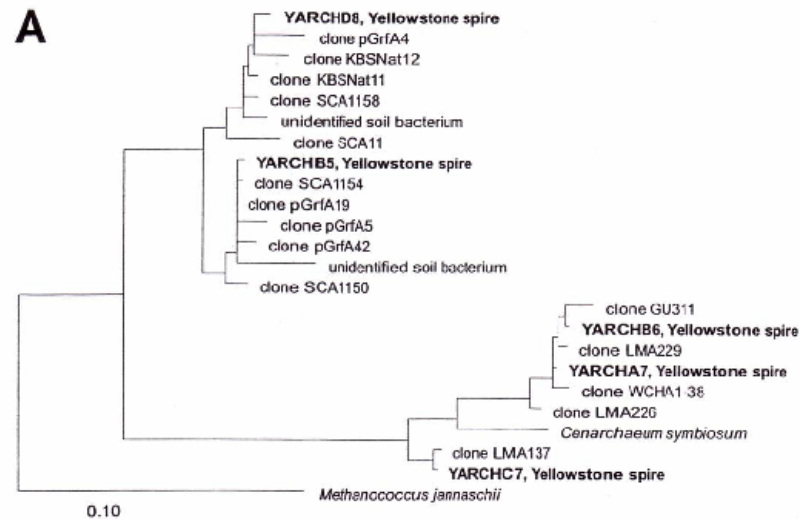
Integration of Science into Park Management: Yellowstone Case Studies



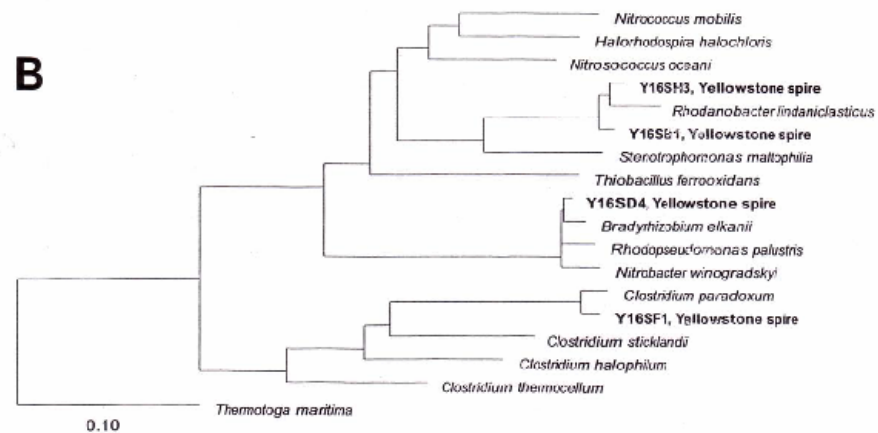




A



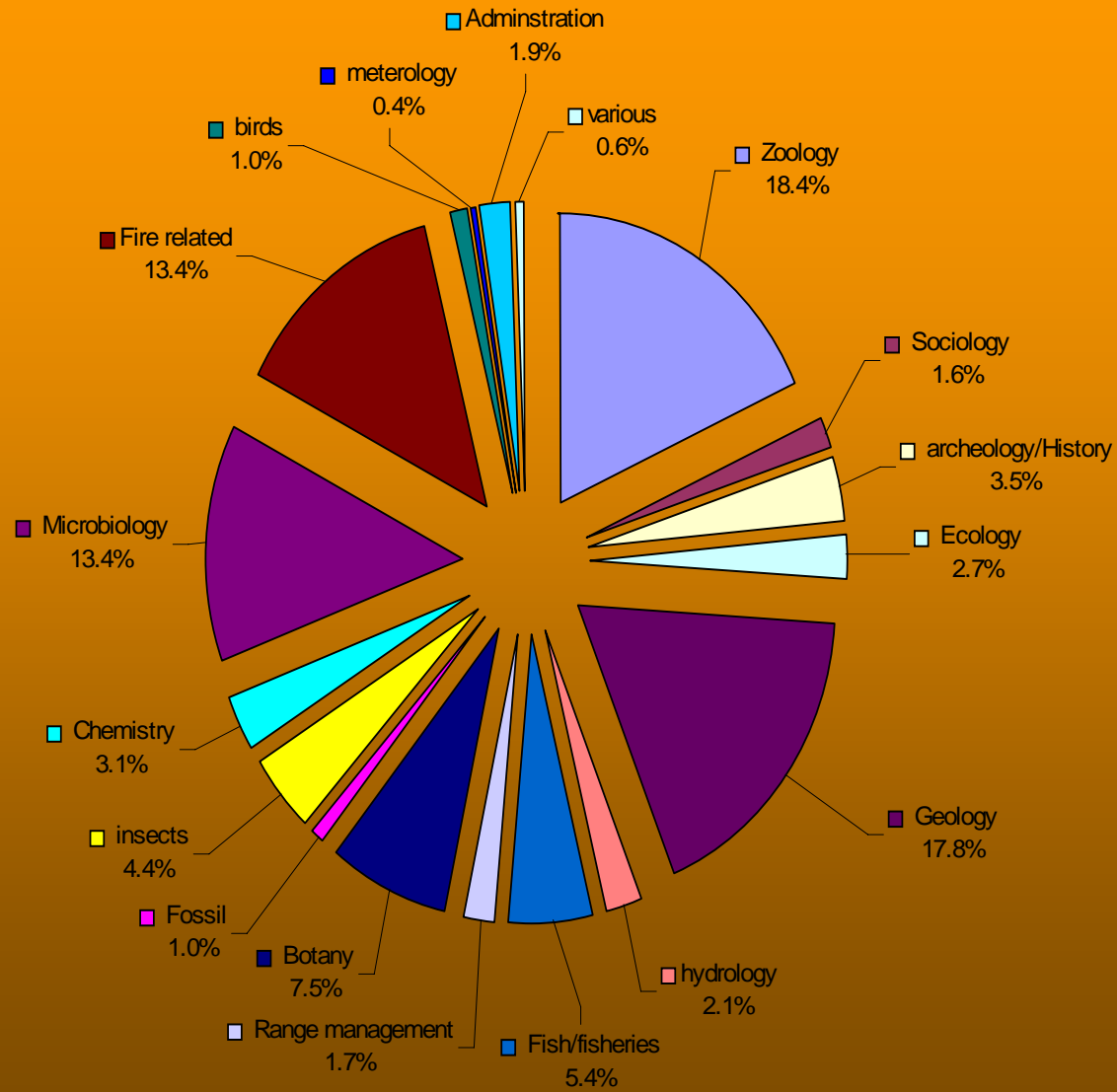
B



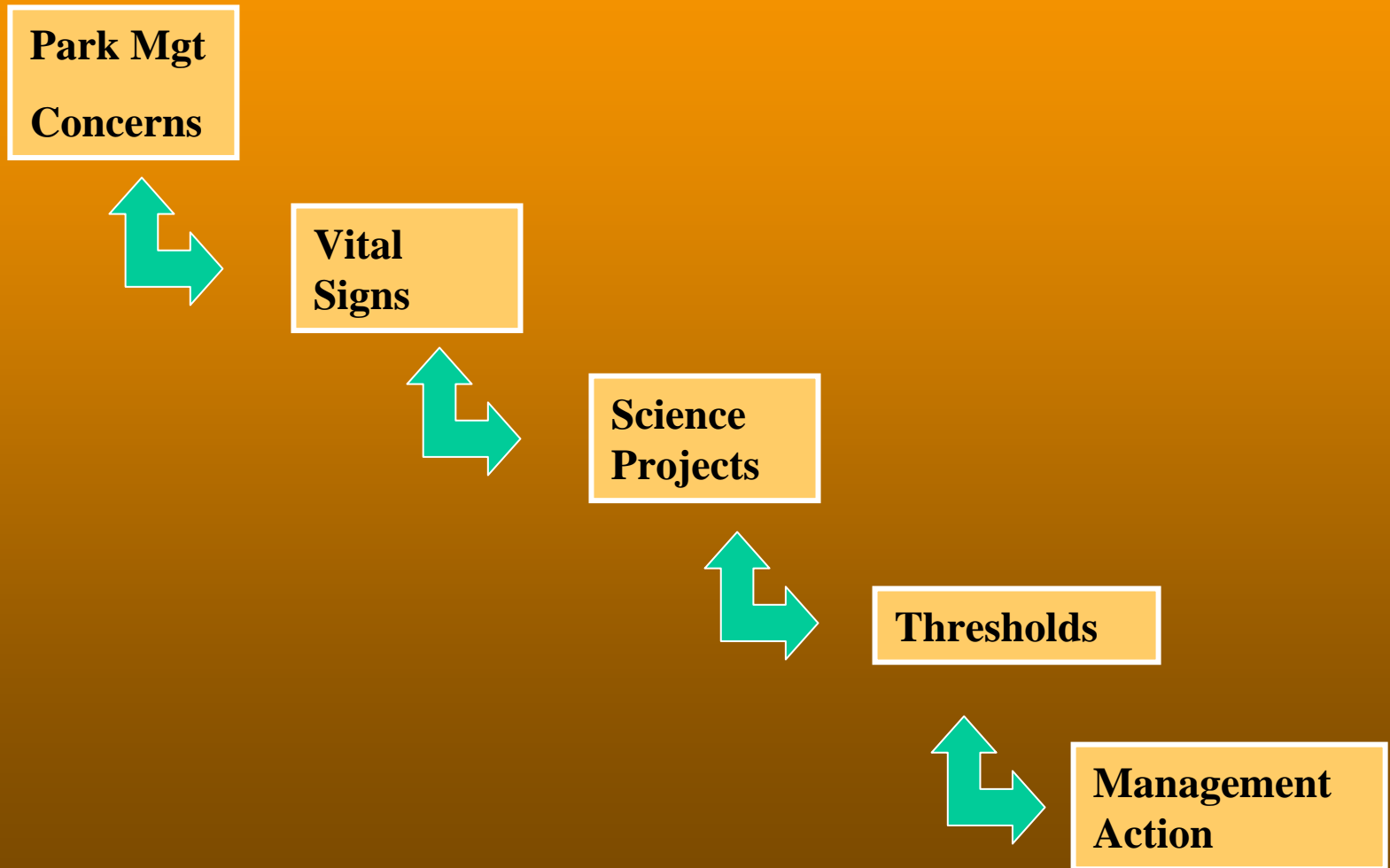
Reconstructed phylogenetic tree based on 16S rRNA sequences that were retrieved from a spire of Yellowstone National Park.

A. Relationships of archaeal clones. **B.** Relationships of bacterial clones. Bars indicate 10% estimated sequence divergence.

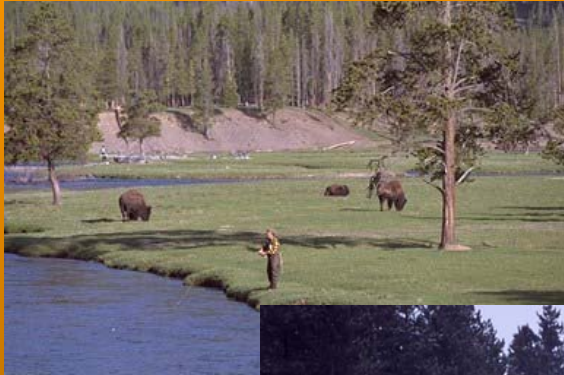
Scientific Research 1989-1996 Total No. of 1444



General Conceptual Model



Case Studies



Dozens of Vital Signs have been identified for the Greater Yellowstone Network

Level 1	Level 2	Vital Signs
Air and Climate	Air Quality	Atmospheric deposition
		Oversnow emissions
		Visibility
	Weather	Climate
Geology and Soils	Geomorphology	Glaciers
		Stream sediment transport
	Subsurface Geologic Processes	Geothermal features
		Geothermal water chemistry
		Seismic activity
	Soil Quality	Soil structure and stability
		Soil biota
Water	Hydrology	Ground water quantity
		Arid seep and spring
		Reservoir and lake elevation
		Streamflow
	Water Quality	Biogeochemical flux
		Chloride flux
		Water chemistry
		Ground water quality
		E.coli (Escherichia coli)
		Algae
		Aquatic invertebrate assemblages
		Water temperature

Level 1	Level 2	Vital Signs
Biological Integrity	Invasive Species	Invasive plants
		Exotic aquatic assemblages
	Infestations and Disease	Forest insect and disease
		Whitebark pine
		Vertebrate disease
	Focal Species or Communities	Aspen
		Riparian/riverine
		Shrub-steppe
		Insects
		Beaver
		Meso-carnivores
		Amphibians
		Landbirds
		Native aquatic assemblages
		Alpine
		Cushion plant
		Ungulates
	At-risk Biota	Birds of concern
		Large carnivores
Human use	Visitor and Recreation Use	Backcountry day use
		Backcountry overnight use
		Visitor use
Ecosystem Pattern and Processes	Fire	Fire
	Land Use and Cover	Land use
		Land cover
	Soundscape	Soundscapes

The network selected 12 Vital Signs to be funded by the I&M program

Level 1	Level 2	Vital Sign
Air and Climate	Air Quality	Atmospheric deposition
		Oversnow emissions
		Visibility
	Weather	Climate
Geology and Soils	Geomorphology	Glaciers
		Stream sediment transport
	Subsurface Geologic Processes	Geothermal features
		Geothermal water chemistry
		Seismic activity
	Soil Quality	Soil structure and stability
		Soil biota
Water	Hydrology	Ground water quantity
		Arid seep and spring
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		Chloride flux
		Water chemistry
		Ground water quality
		E.coli (Escherichia coli)
		Algae
		Aquatic invertebrate assemblages
		Water temperature

Vital Signs			Vital Sign
			Invasive plants
			Exotic aquatic assemblages
			Forest insect and disease
			Whitebark pine
			Vertebrate disease
			Aspen
			Riparian/riverine
			Shrub-steppe
			Insects
			Beaver
			Meso-carnivores
			Amphibians
			Landbirds
			Native aquatic assemblages
			Alpine
			Cushion plant
			Ungulates
			Birds of concern
			Large carnivores
			Backcountry day use
		Visitor and Recreation Use	Backcountry overnight use
			Visitor use
	Ecosystem Pattern and Processes	Fire	Fire
			Land use
		Land Use and Cover	Land cover
			Soundscapes

Many other critical Vital Signs are being monitored by other programs

Level 1	Level 2	Vital Sign
Air and Climate	Air Quality	Atmospheric deposition
		Oversnow emissions
<p>Together they form a more balanced comprehensive monitoring program</p>		
Water		Bio
		Chloride flux
		Ground water quality
		E.coli (Escherichia coli)
		Algae
		Water temperature

Together they form a
more balanced
comprehensive
monitoring program

- Vital Signs

Climate

Streamflow

Water chemistry

Aquatic invertebrate assembl

Arid seep and spring

structure and stability

sive plants

ic aquatic assemblages

bark pine

ibians



Land use

At-risk Biot

Human
n USE

Visitor and Recreation U

Ecosystem Pattern and Processes

Fire

Land Use and Cover

Soundscape

- On-going monitoring

Visibility

Atmospheric deposition

Geothermal features

Seismic activity

Chloride flux

Water temperature

Reservoir and lake elevation

Vertebrate disease

Ungulates

Large carnivores

Birds of concern

Land cover

Fire

Backcountry overnight use

Soundscape

General Observations

4. Monitoring tells us something has changed—additional science explains why
5. Thresholds are generally complex

General Observations

6. Communicating the results of science to managers is the most important thing we do—and we don't do it that well!

General Observations

**Report to
Management**



**Peer-
Reviewed
Manuscript**

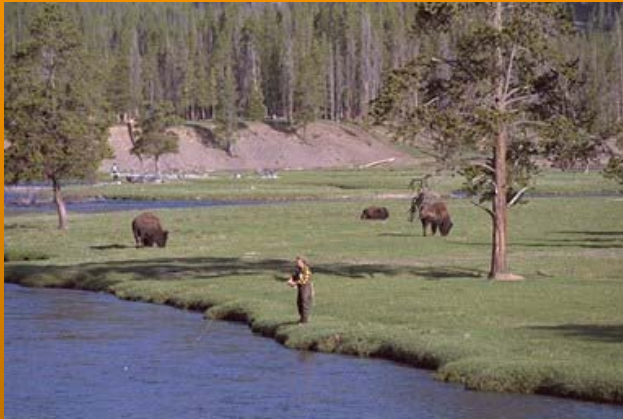


**Popular
Article**

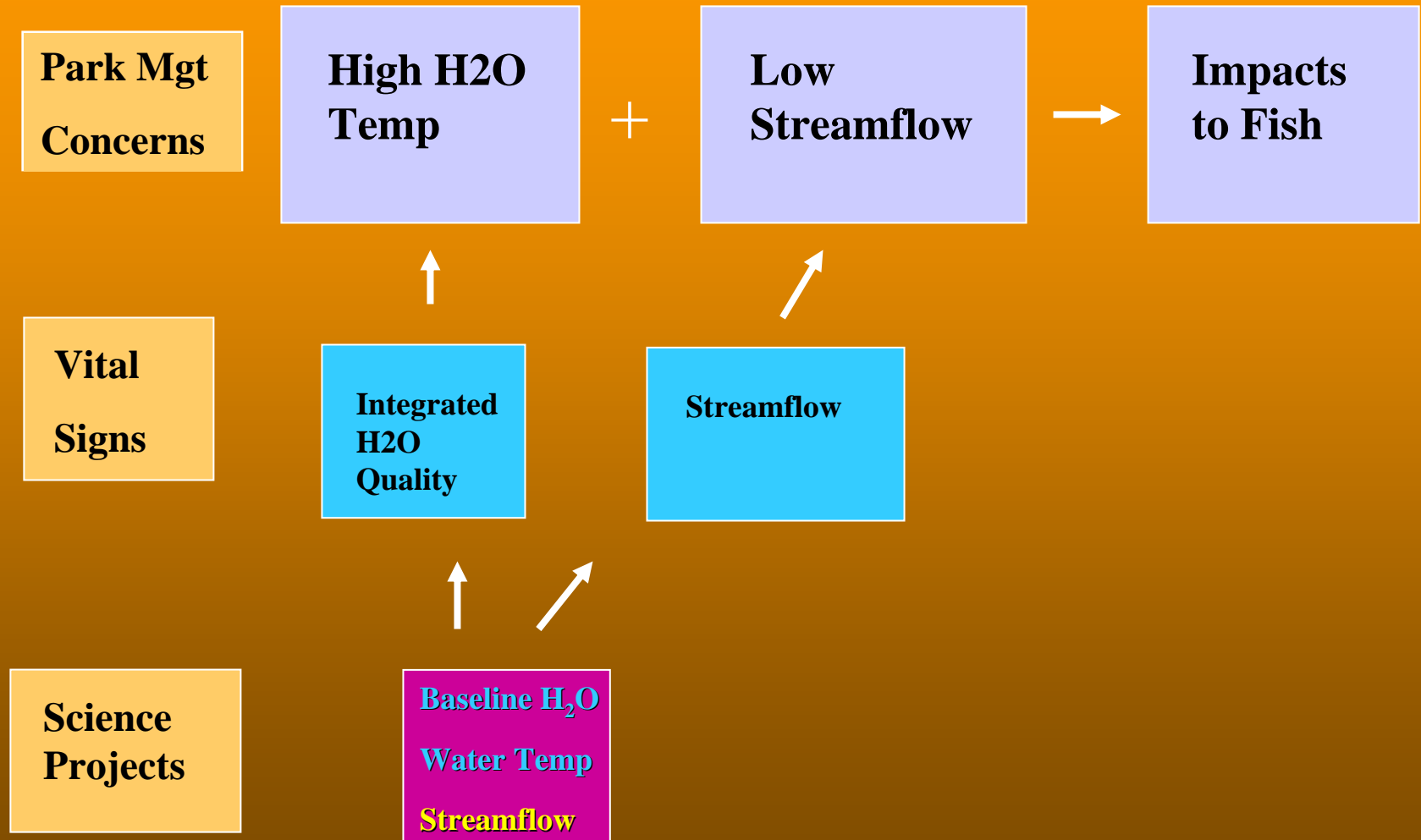


Soundbite

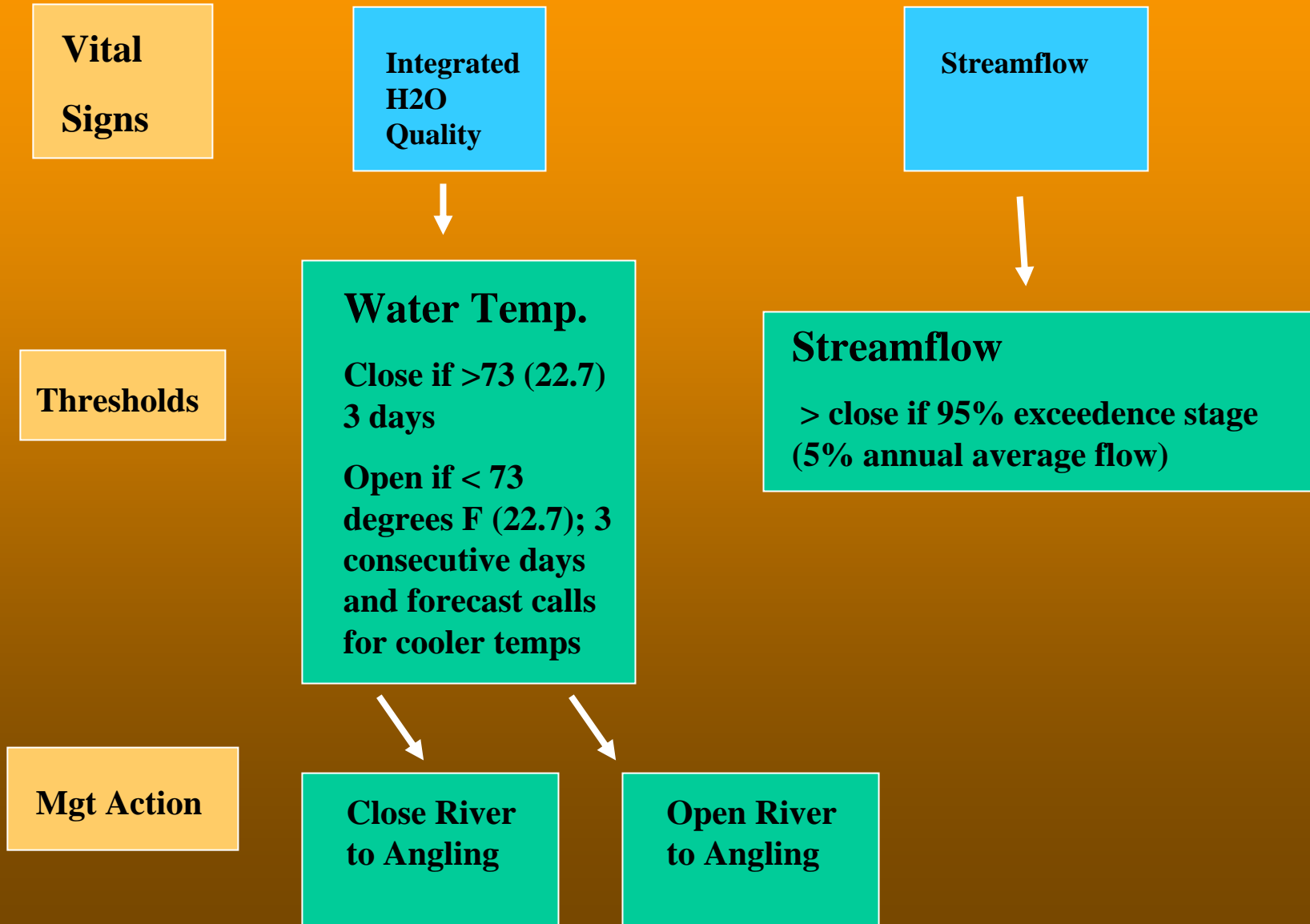
Drought Contingency—Angling



Drought Contingency—Angling



Drought Contingency—Angling

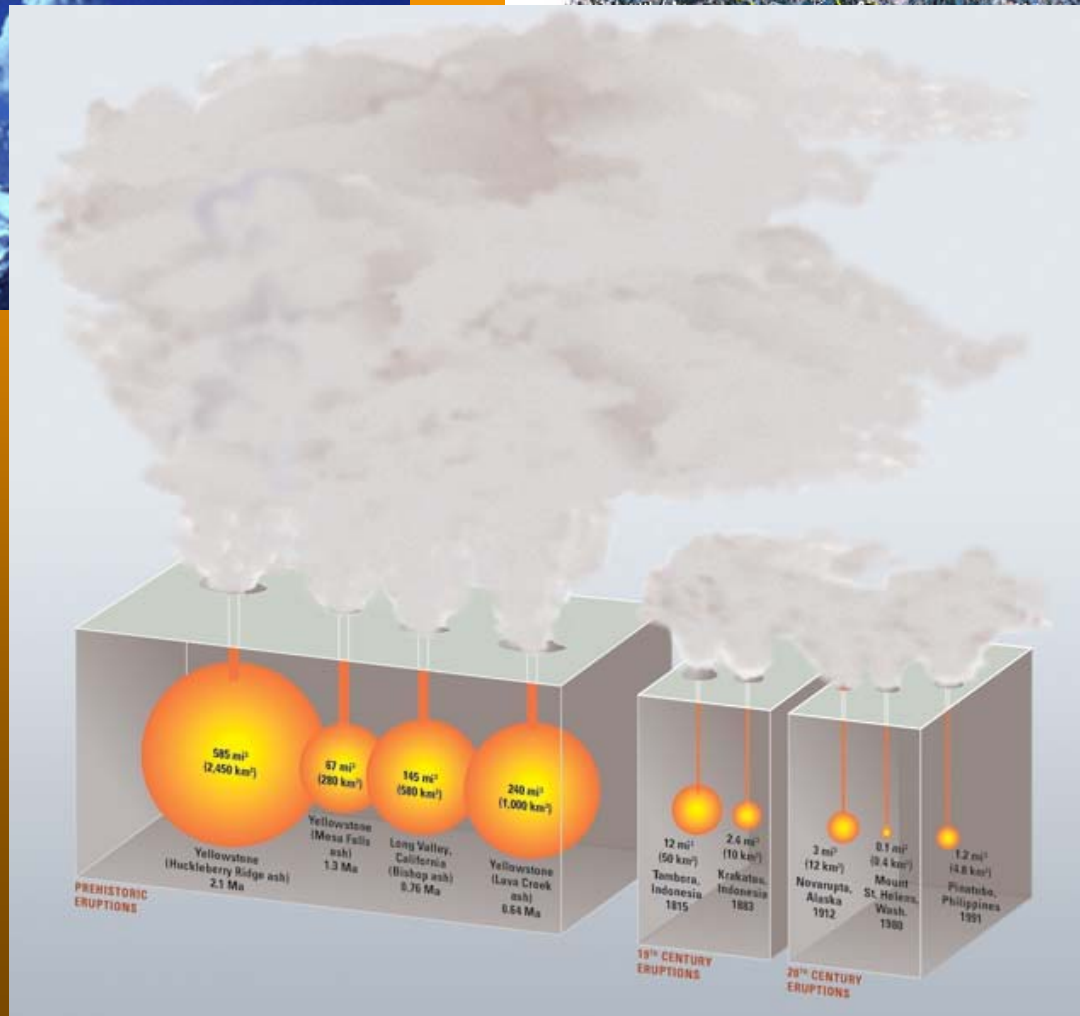


Drought Contingency—Costs

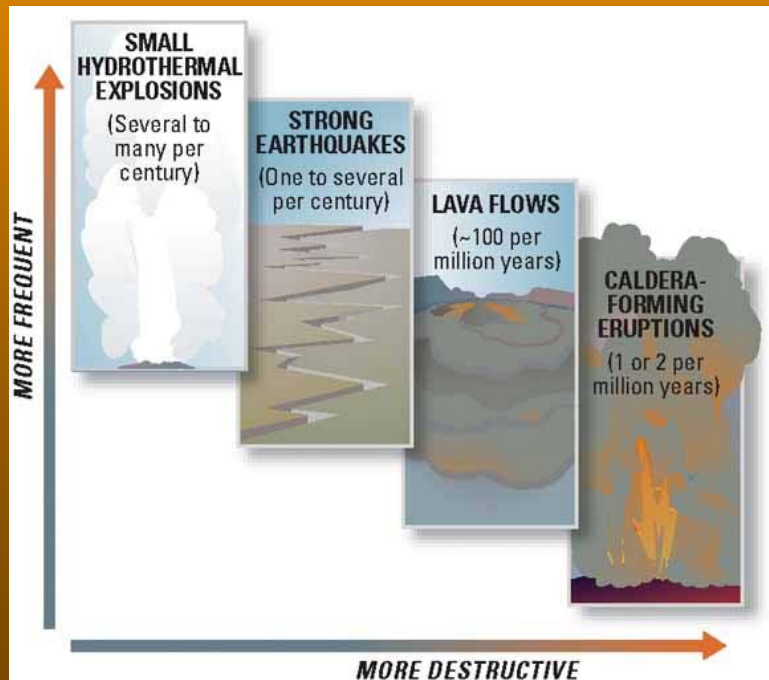
NPS Costs: Year 1: \$6000; Year
2: \$16,000

USGS Costs: Year 1: \$0; Year
2: \$50,000 (install gauging
station)

Volcano Hazards



Volcano Hazards



Volcano Hazards

Park Mgt
Concerns

Earthquakes

Volcanic
Eruptions

Steam
Explosions

Vital
Signs

Seismic
Activity

Geothermal
Features

Science
Projects

Seismic Network

Campaign Seismic

Borehole Seismic

Campaign GPS

Campaign Leveling

InSAR Imaging

Borehole Strainmeters

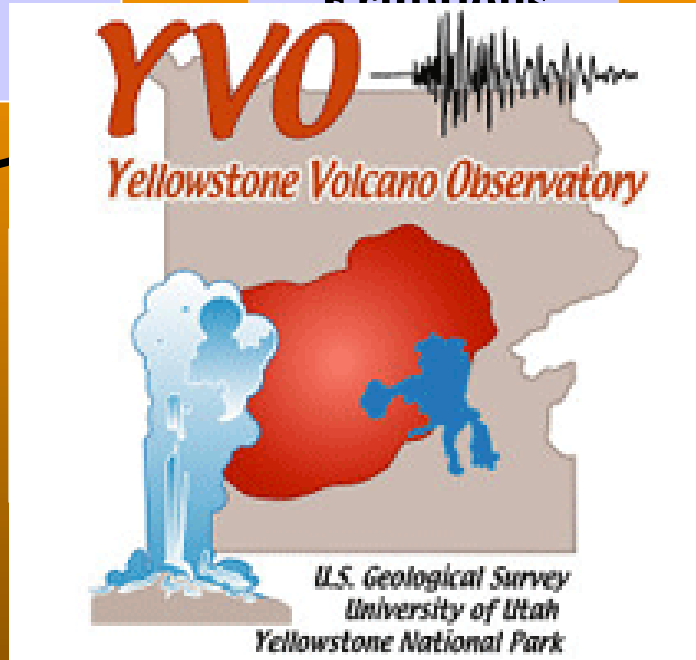
Tiltmeters

Airborne gas

Tree Ring CO₂

*Hydrothermal
Network*

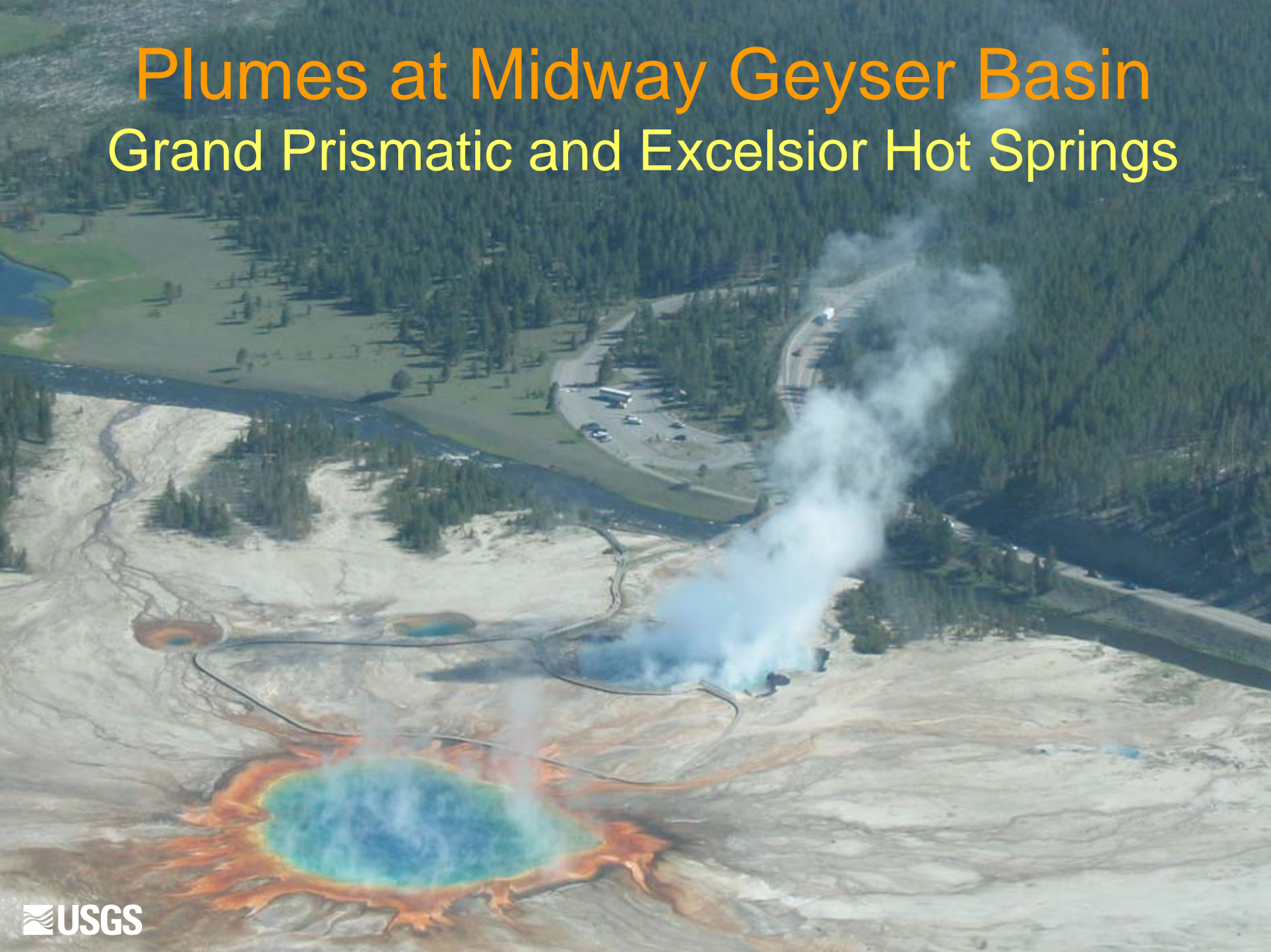
*Geothermal
Monitoring*



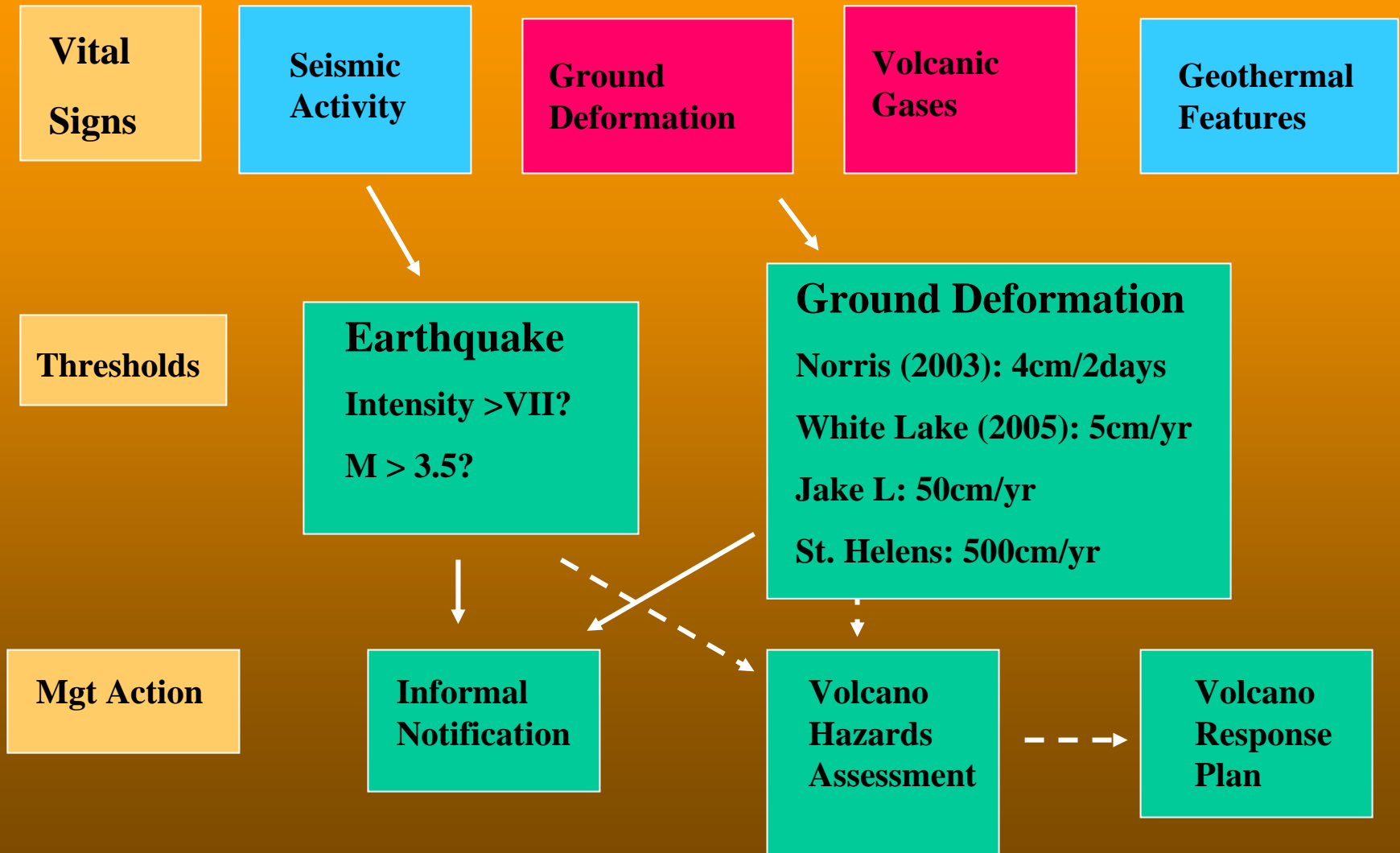
Volcano Hazards



Plumes at Midway Geyser Basin Grand Prismatic and Excelsior Hot Springs



Volcano Hazards



Volcano Hazards--Funding

NPS: ~ \$200,000/year

YVO: ~ \$430,000/year

USGS: ~ \$350,000/year

U of U: ~ \$75,000

Total Annual Ops: \$1,055,000

U of U/USGS: \$675,000

Earthscope: \$100K (05); \$400K (07)

Total Investments: \$1,175,000

Winter Use

**Winter Use
Plan 1990**

**Winter Use
Assessment
1999**

**Final EIS
2000**

**Final SEIS
2003**

**Temp
Winter Use
EA 2004**

**Final, Final
SEIS *OR*
Final
SSEIS 2007**

Winter Use



Winter Use



Winter Use



Winter Use

**Vital
Signs**

**Integrated
H2O
Quality**

**OSV
Emissions**

**Effects to
Wildlife**

Soundscapes

**Visitor
Use**

**Employee
Exposure**

Thresholds

Air Quality

Developed: 8/3/3

Roads: 1/1/6

NAAQS: 35/9/65

Soundscapes

dB human noise <70dB(A)

Ave sound level <45dB(A)

Audibility <50%

**Mgt
Actions**

BAT

**Limit OSV
numbers**

**Time
Entries**

**Require
Guides**

Winter Use-Funding

NPS BASE: \$422,000/yr

NPS SOFT: >\$1,000,000

NASA: \$300,000

Conclusion

